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Enzymes as a Tool to Investigate Biofilm Structures and to Control Bio films

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Abstract

Biofilm is one of the important part of life cycle in bacteria and a potential source of contamination. Although biofilm has an important aspect due to its nature in resistance to environmental stresses, its structures are variable depending on bacterial species and the knowledge of biofilm structures still remains poorly understood. Because enzymes are generally highly specific for substrates, those enzymes can be used to study biofilm structures or to control biofilms.

Keywords: Biofilm; Enzyme; Structure; Control

Opinion

Bacteria often form biofilms in their lives on both abiotic and biotic surfaces and the biofilms can often affect our human life negatively because they are hard to remove and tend to be resistant to environmental stress conditions including sanitizers and antimicrobials. The pathogenic bacterial cells surviving the stressful conditions in the form of biofilm can be persistent in the environment and cause human infections. Thus, the understanding of biofilm structures is certainly necessary to eventually find a way to easily remove the biofilms or inhibit the biofilm formation.

In many bacterial species, the biofilm is protected in the matrix of extracellular polymeric substances usually composed of proteins, carbohydrates, lipids, and extracellular DNA. Such a structure makes it easy to communicate among the cells through quorum sensing in protected environment. However, the detailed components or structures are not well understood in many times and warrants further studies. Enzymes are usually highly specific for substrates to degrade, and can be potentially used as a useful tool to study biofilm structures. Such an identified substrate playing a pivotal role in the biofilm structures can be a promising target to prevent biofilm formation or degrade the pre-formed biofilms. Several studies have already demonstrated that substrate-degrading enzymes can be a useful tool to investigate the biofilm structures or the mechanism of biofilm formation by observing the reduction of biofilm mass or the inhibition of biofilm formation after enzyme treatments [1-4]. For example, extracellular DNA in bacterial biofilms has become a promising target for biofilm control through observing the effect of DNase in degrading biofilms. In addition, alpha-amylase was able to inhibit the biofilm formation or to reduce the pre-formed biofilms of Staphylococcus aureus isolates, suggesting that carbohydrates play an important role in the integrity of S. aureus biofilms [1].

Such an enzyme treatment can be also an useful tool to control biofilms. Enzyme treatment can degrade pre-formed biofilms or inhibit the biofilm formation. Also, disintegration of biofilm structures by enzymes can make it easy for antimicrobials including antibiotics to penetrate the biofilm structures and inactivate the bacterial cells. Indeed, previous studies demonstrated the increased inactivation of pathogenic bacterial cells in biofilms by antibiotics in the presence of enzymes such as DNase I [3]. Even though the cost can be problematic, the eco-friendly nature makes enzyme a promising method to control biofilms in our environments. In addition, such a target-specific enzyme can be applied in many different ways such as anti-biofilm coatings [5].

Therefore, enzymes can be used as a useful tool to study biofilm structures and control biofilms.

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